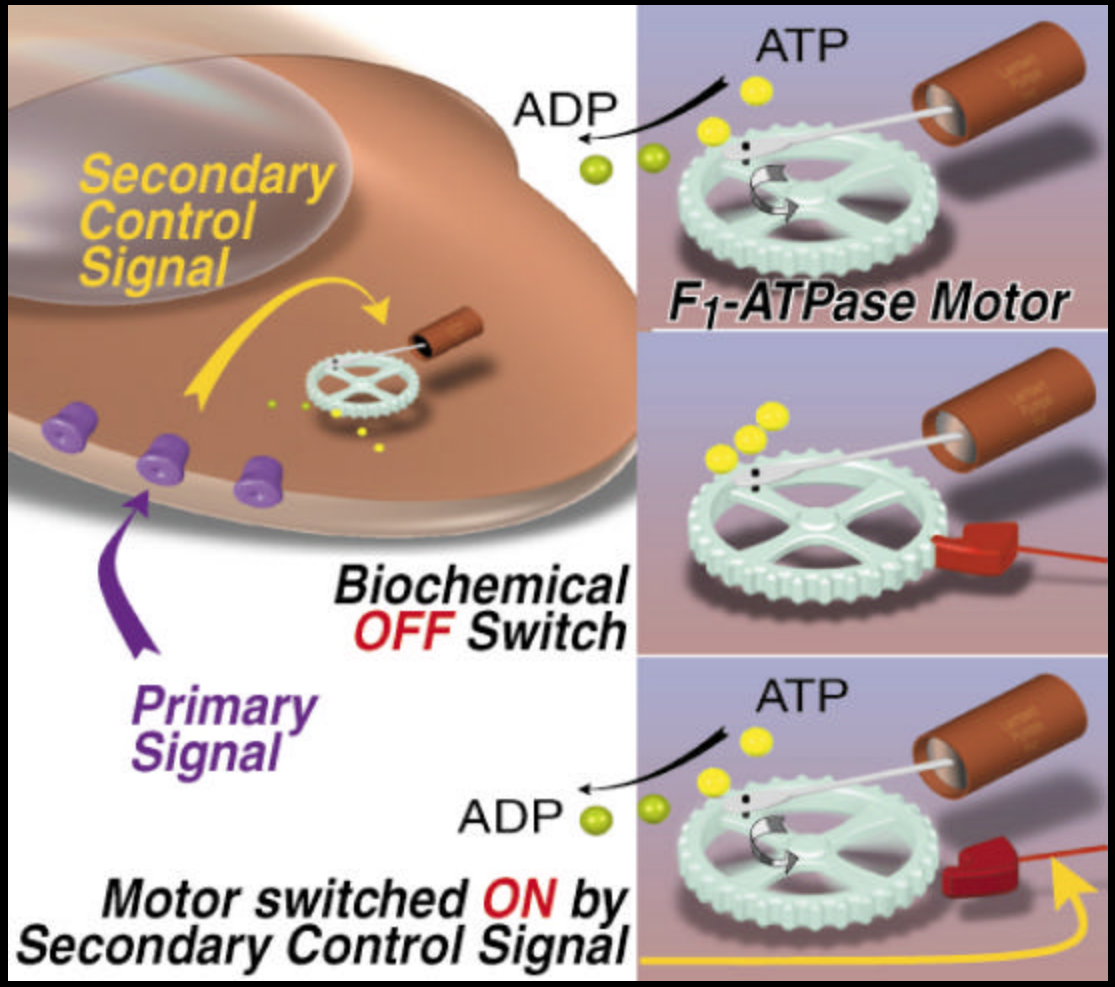
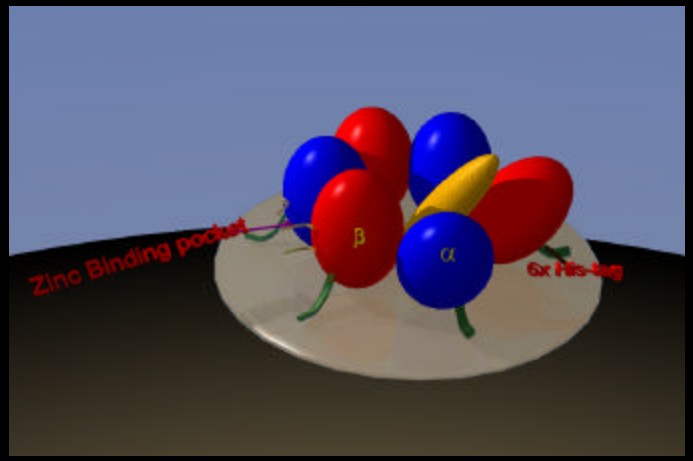
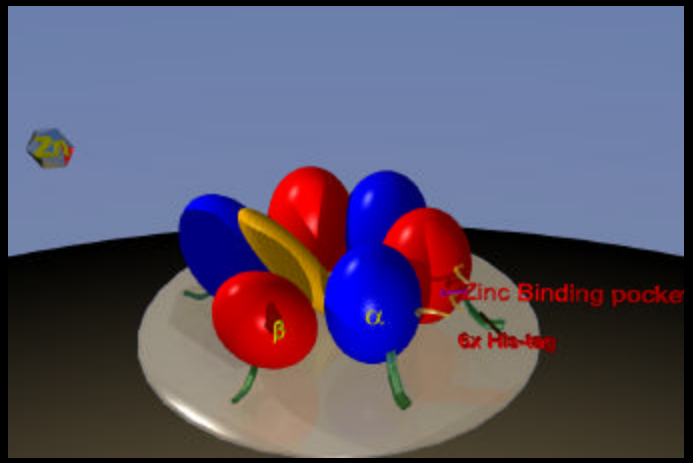
Secondary Biochemical Control of F_1-ATPase Biomolecular Motors

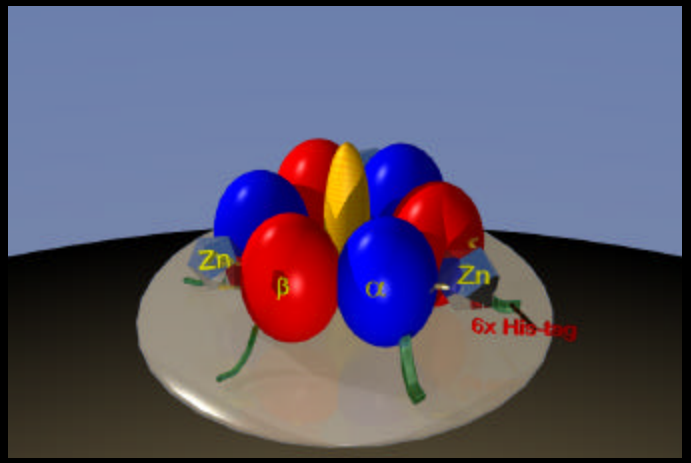
Engineering Control into Biomolecular Motors



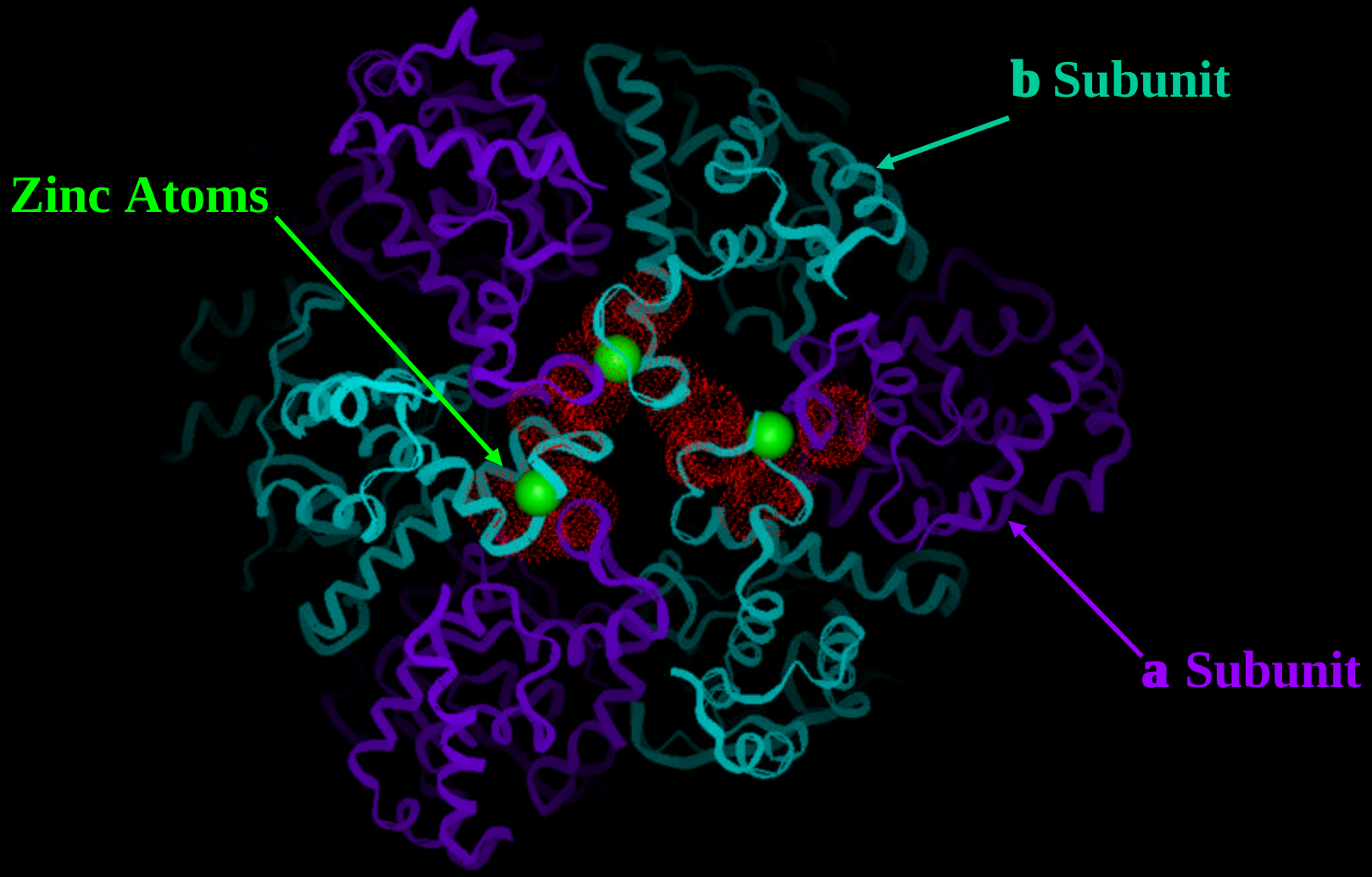
Secondary Chemical Control of F_1-ATPase







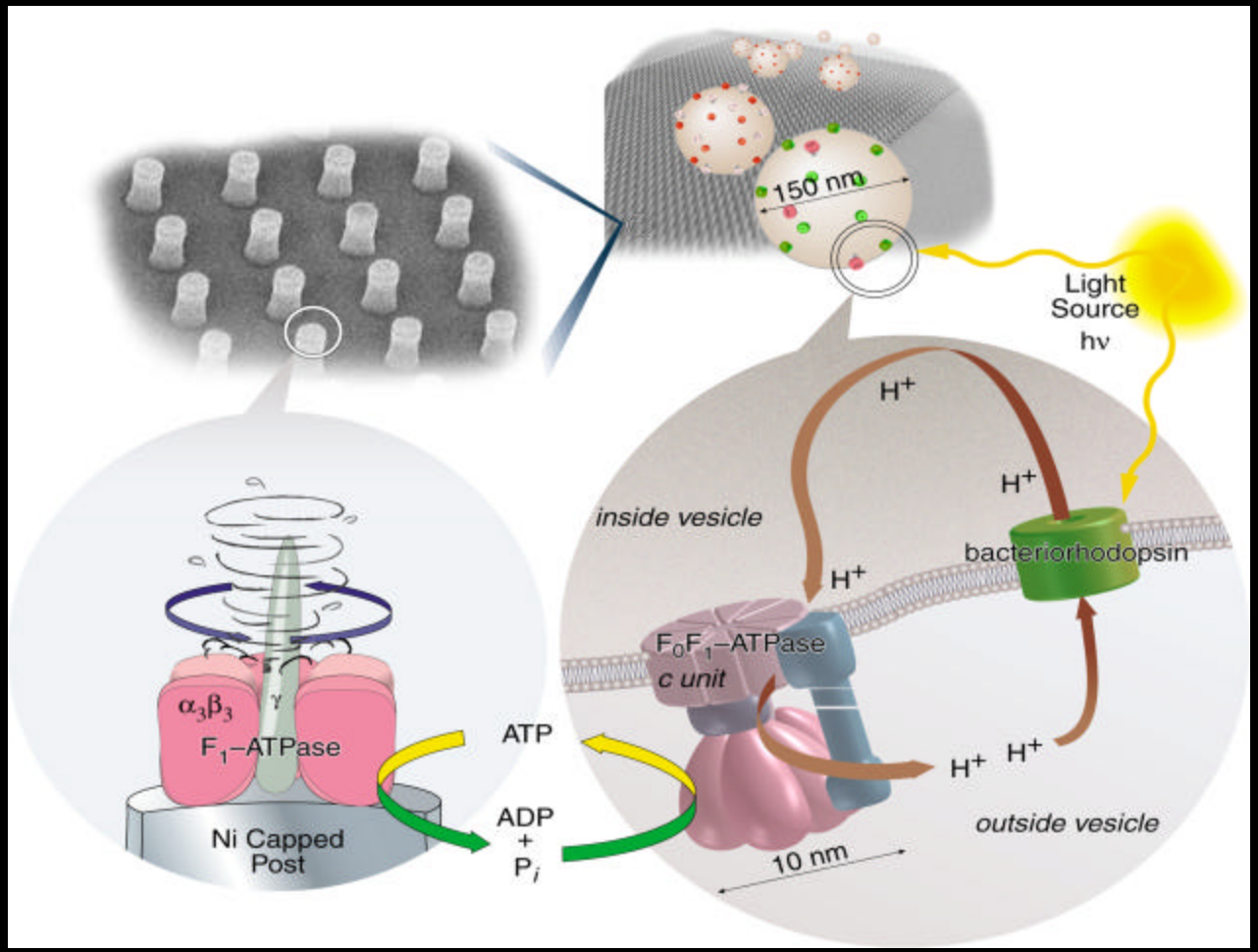
Secondary Control of the F_1-ATPase Molecular Motor



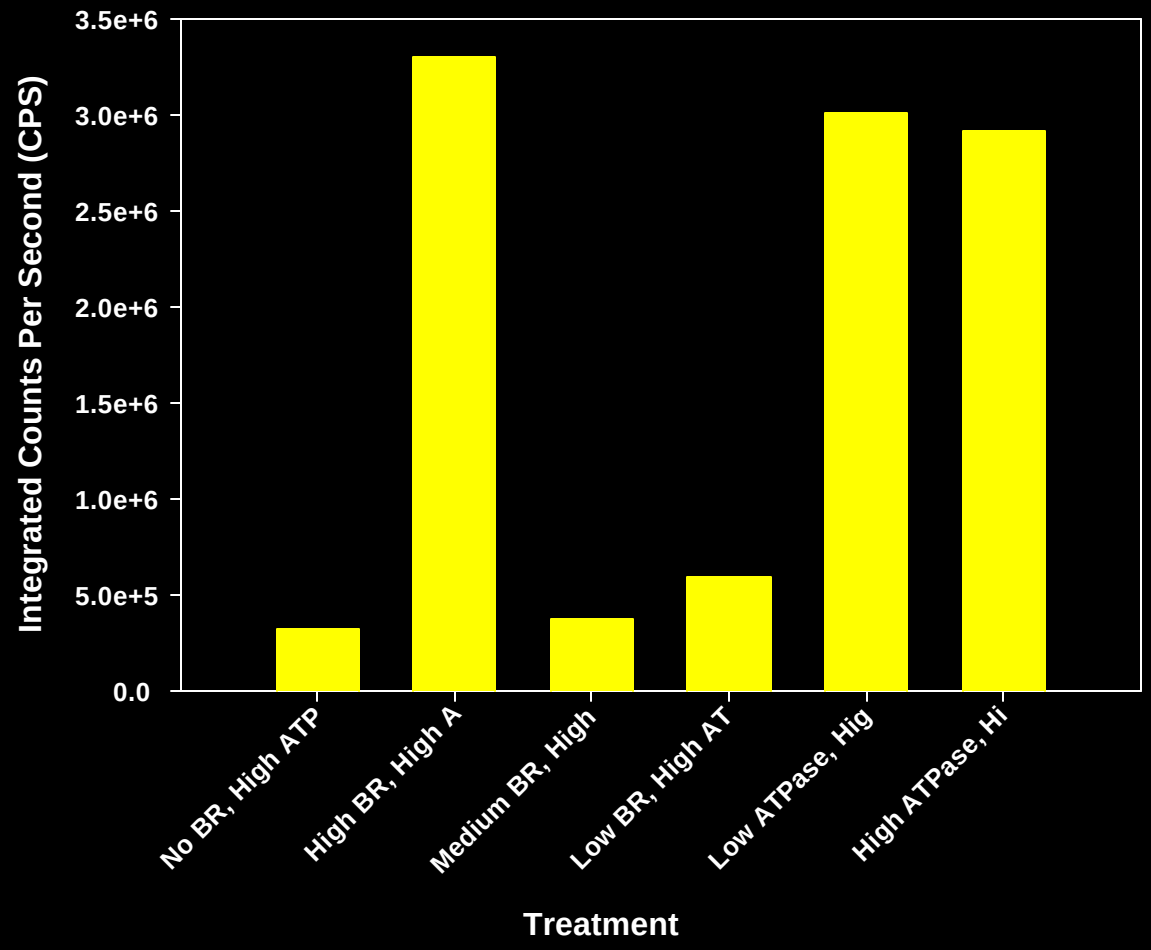
Zinc Binding Site

Photonic Integrated NEMS Devices Powered by Biomolecular Motors

Photon Fueled Biomolecular Motor Powered NEMS

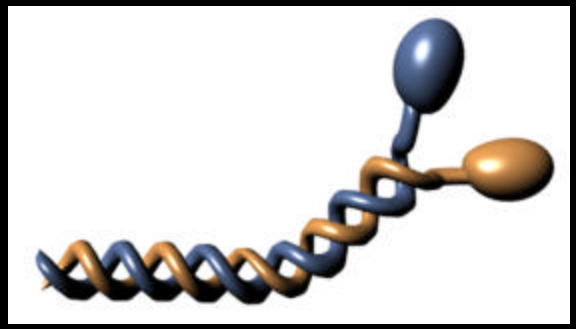


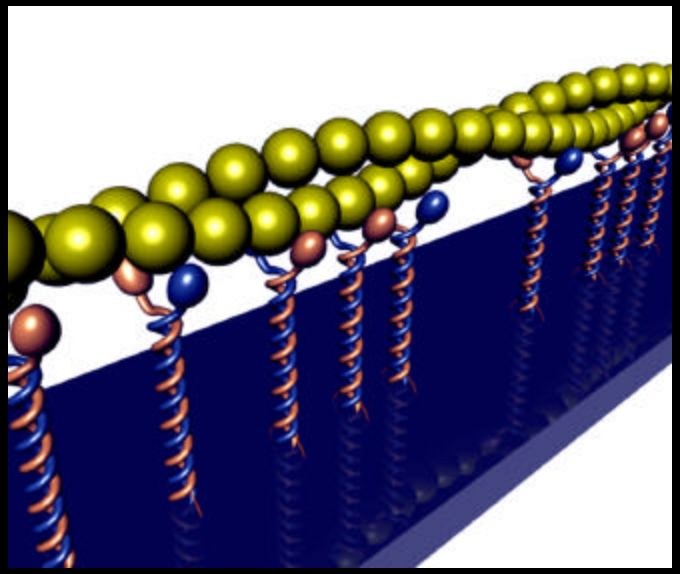
ATP Production by BR-F_oF_1-ATPase Liposomes

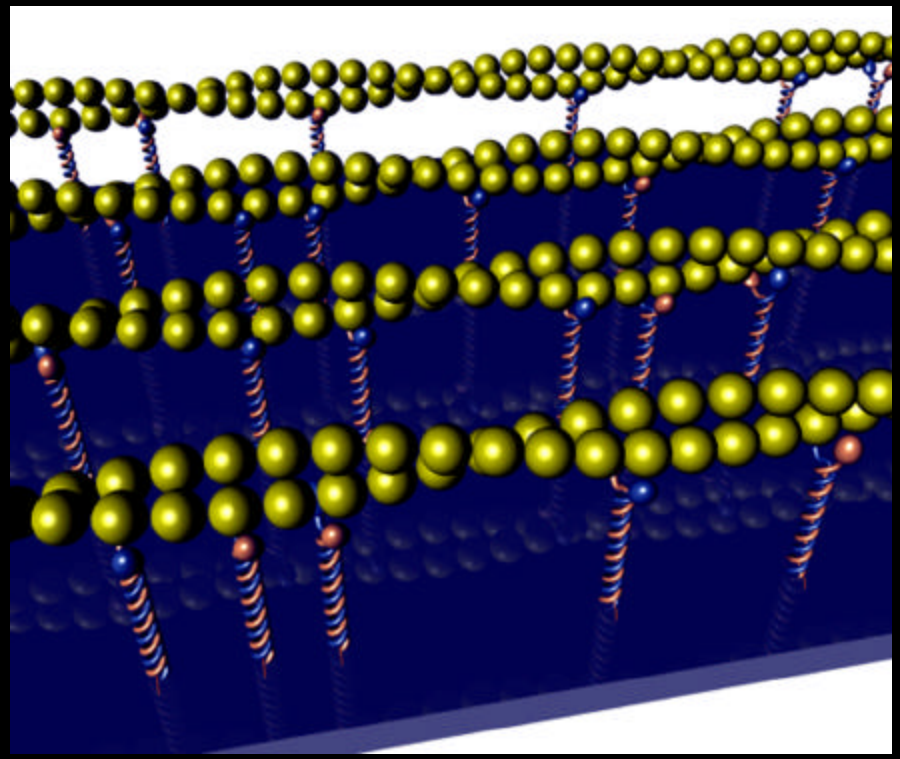


Construction of an Actinomyosin-actuated Shutter System

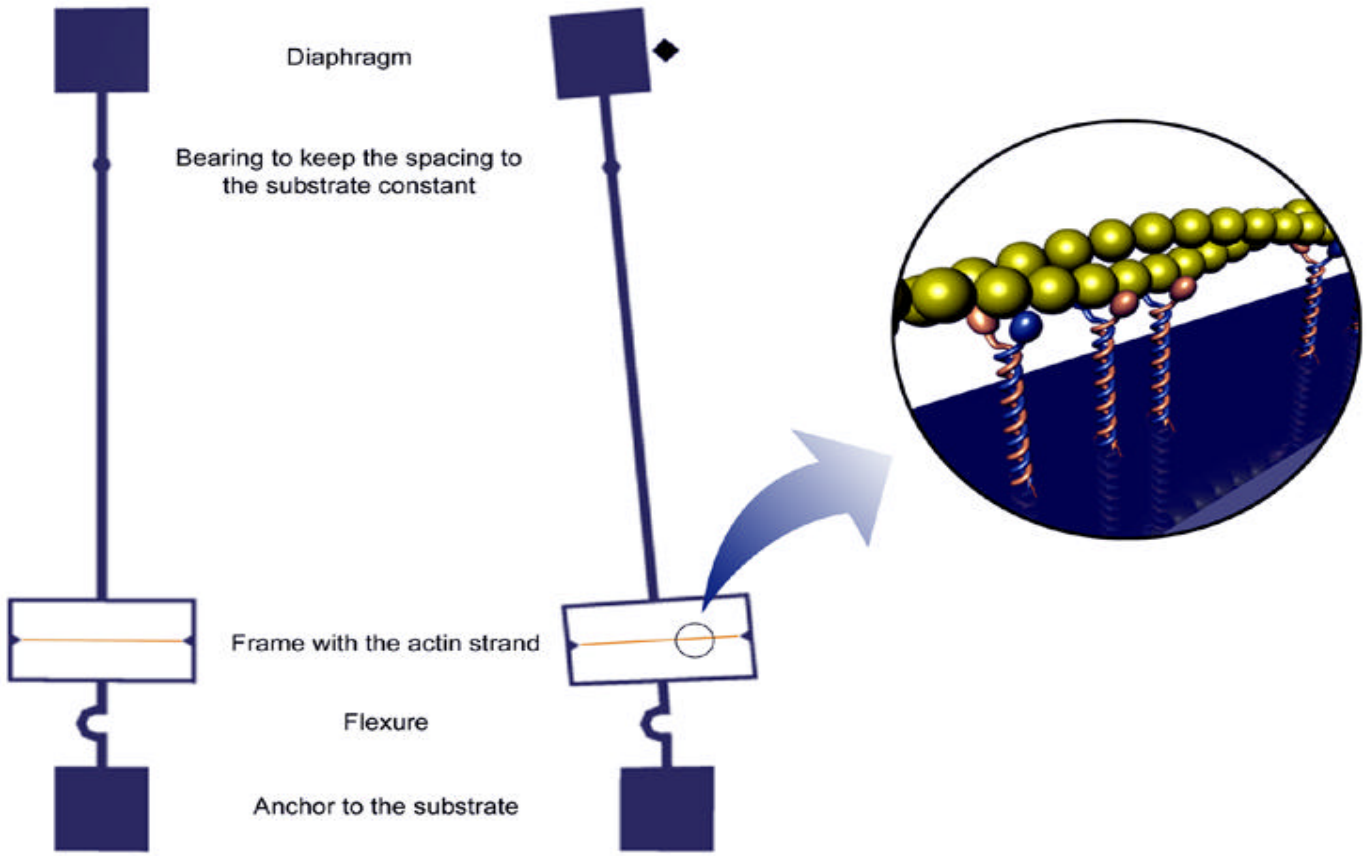
Actinomyosin Biomolecular Motor Complex





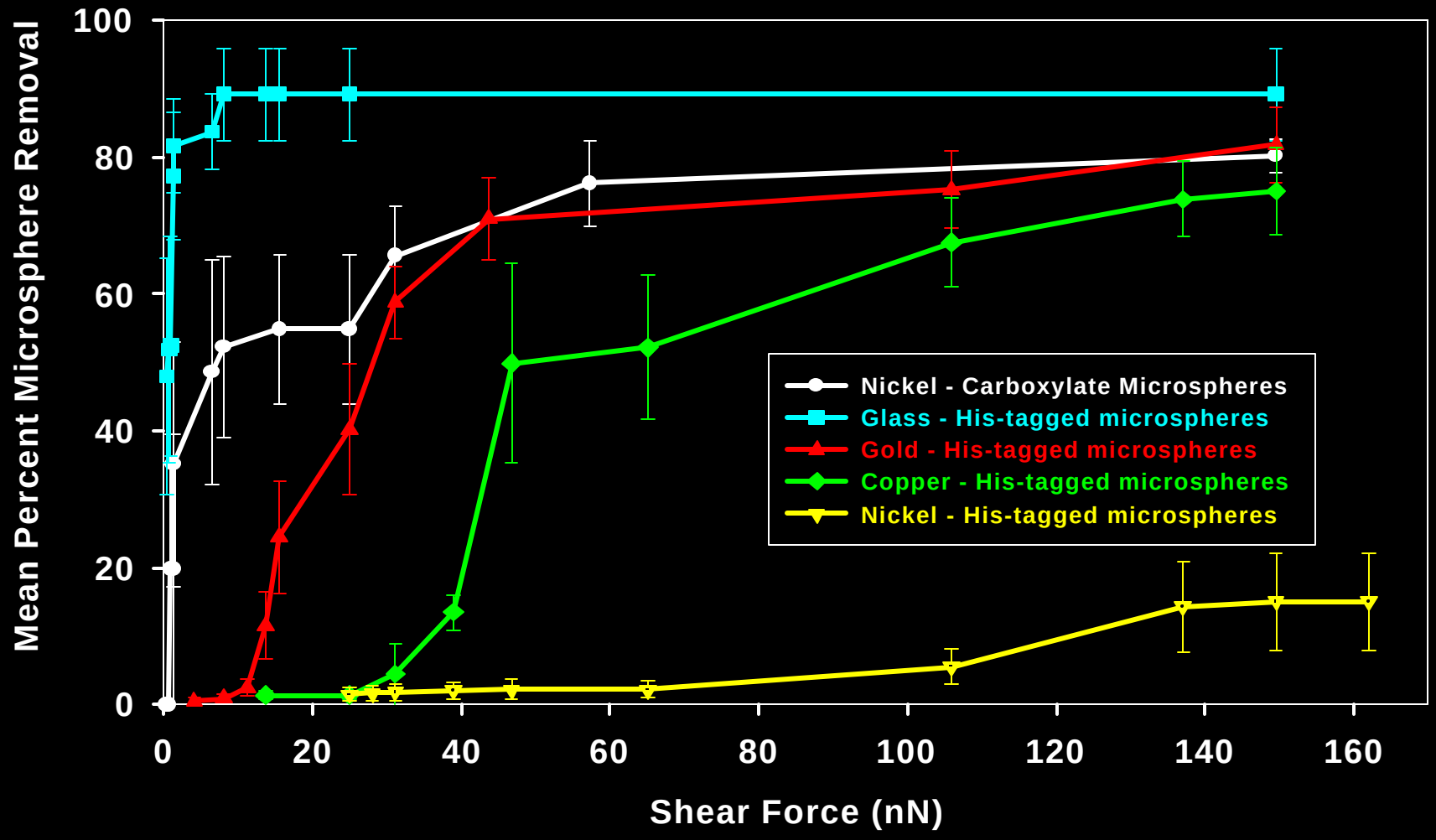


Actinomyosin-driven Light Shutter System

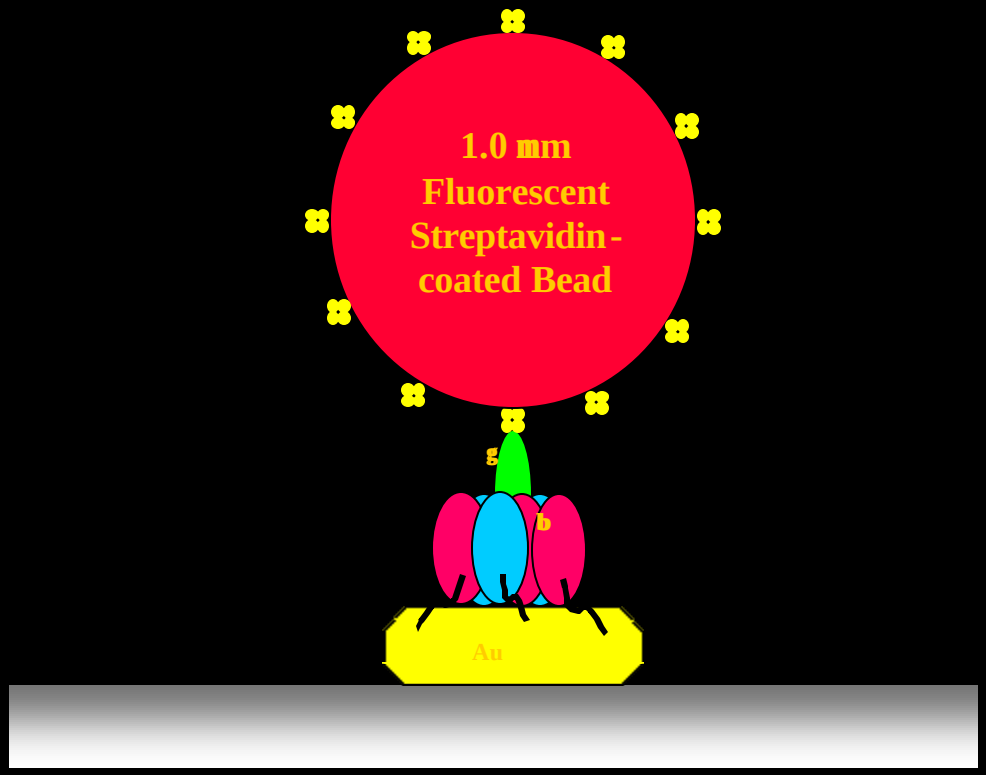


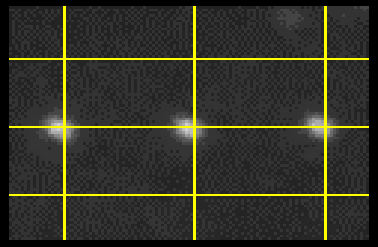
Engineering and Fabrication of Biocompatible Nanostructures

Evaluation of Metallic Substrates for Binding His-tagged Microspheres

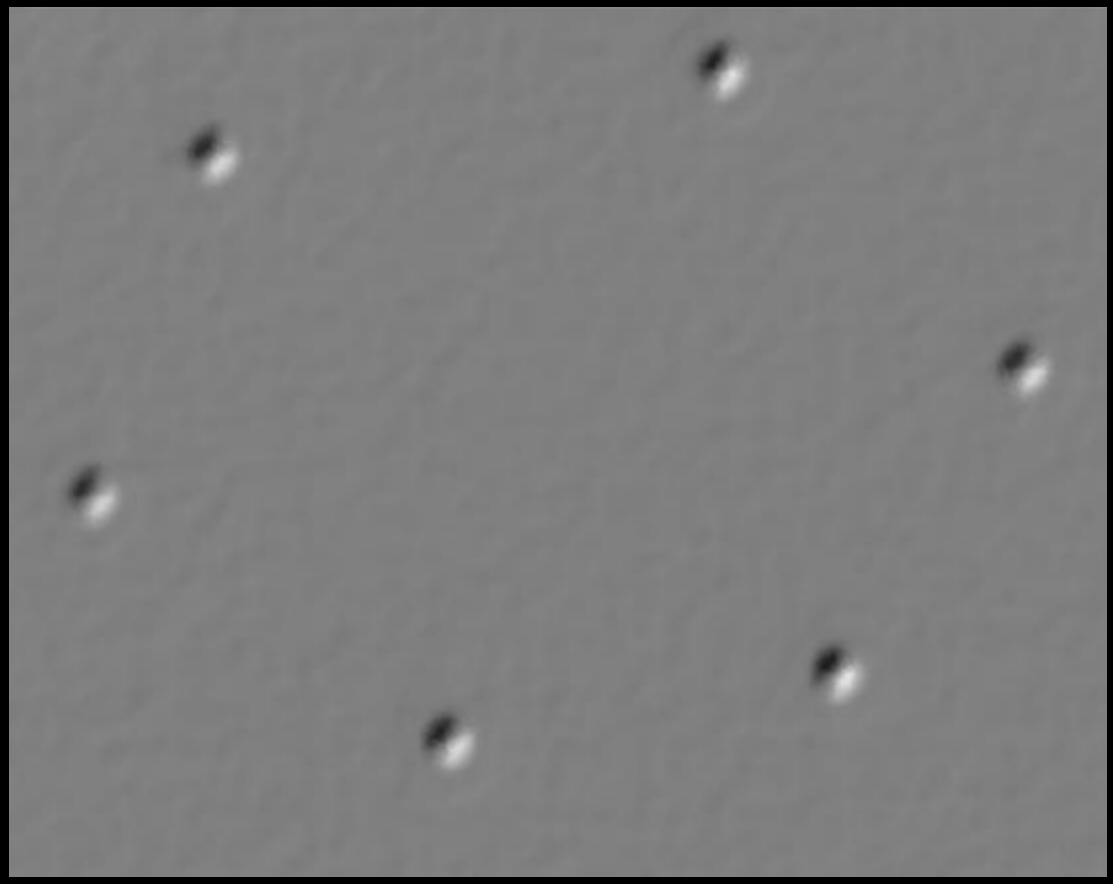


F_1-ATPase-Fluorescent Bead and Au Array



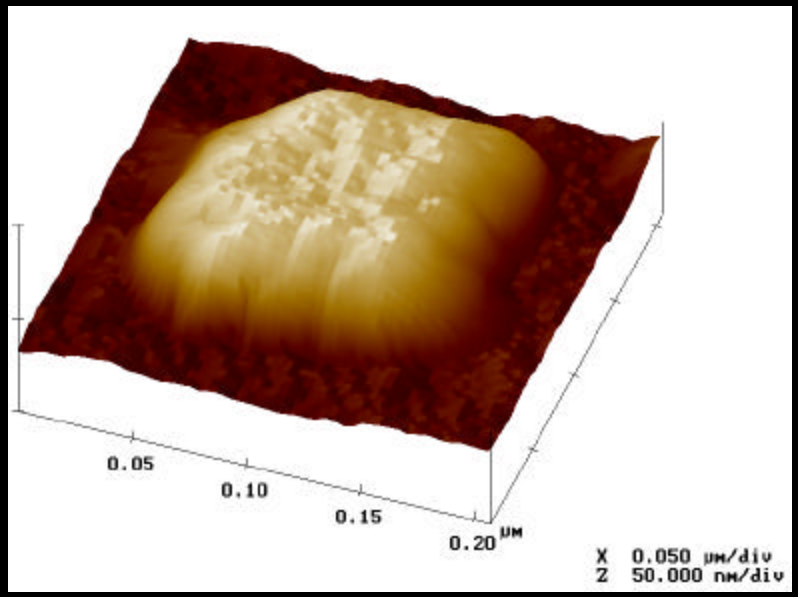


Array of Single F_1-ATPase Molecules

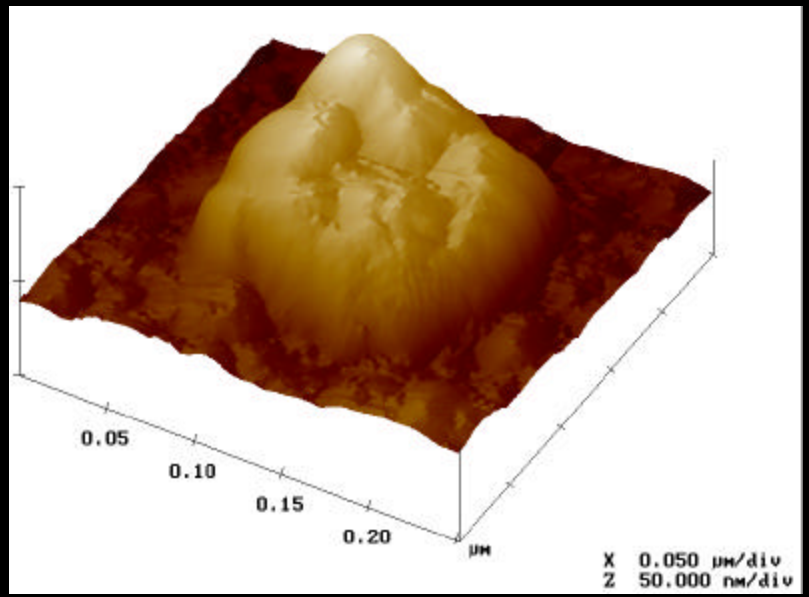


AFM Image of F_1-ATPase Attached to Engineered Surface

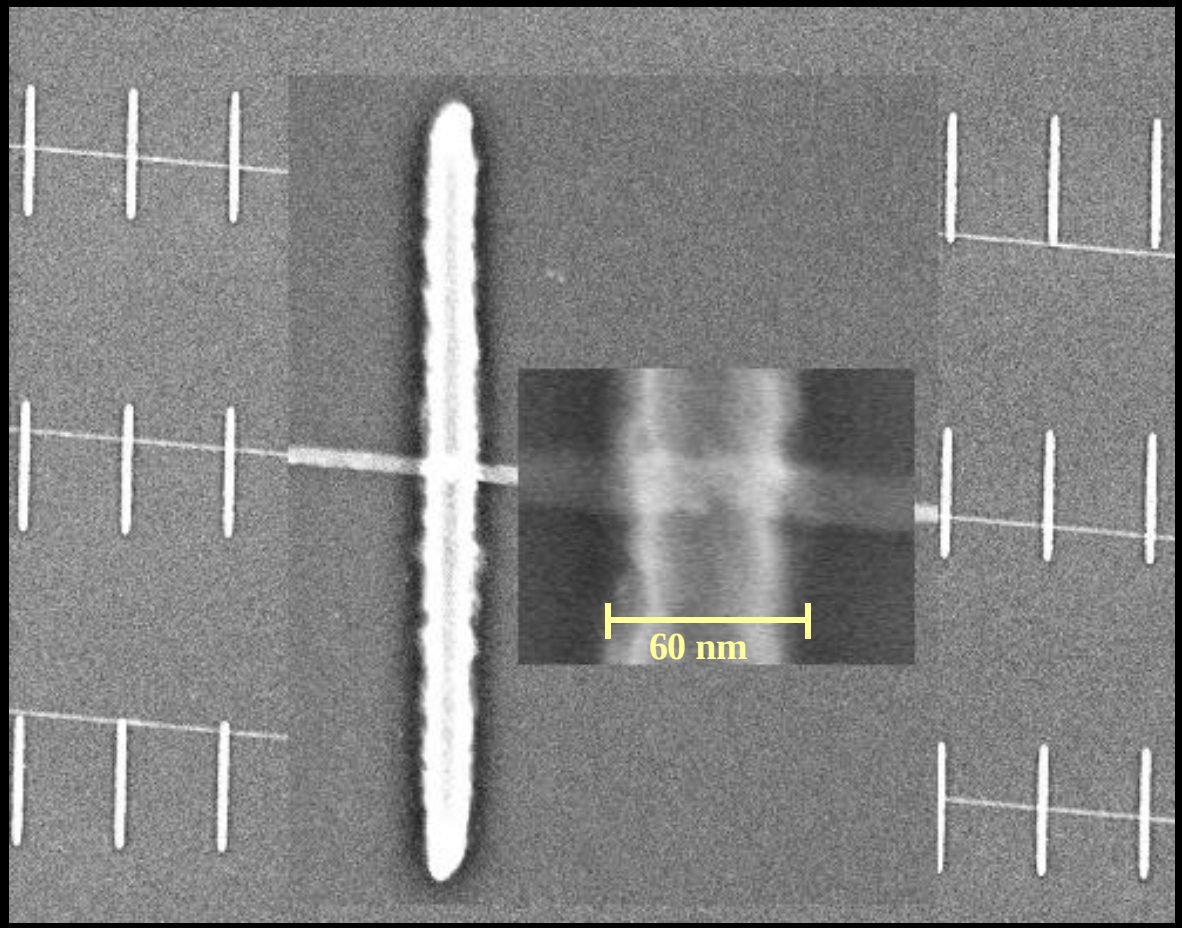
No Motor



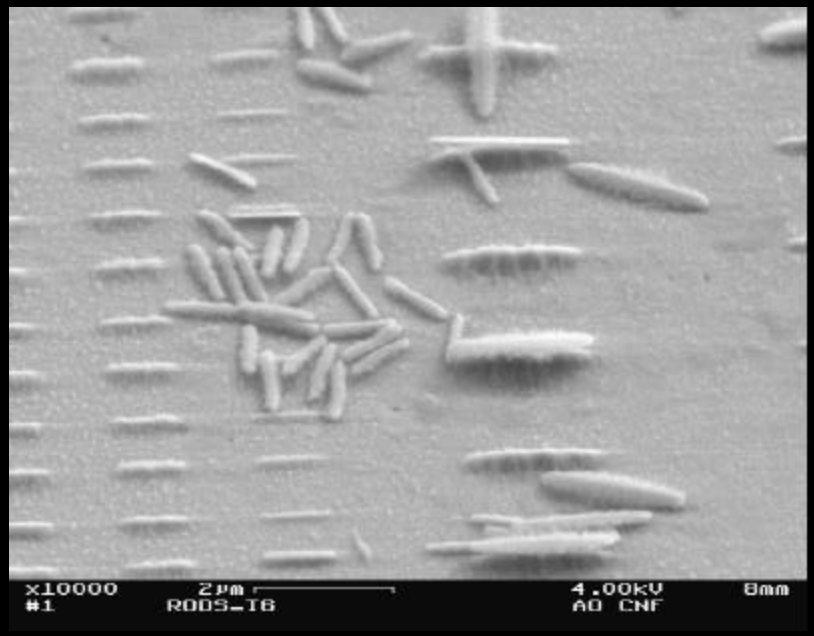
Motor Attached

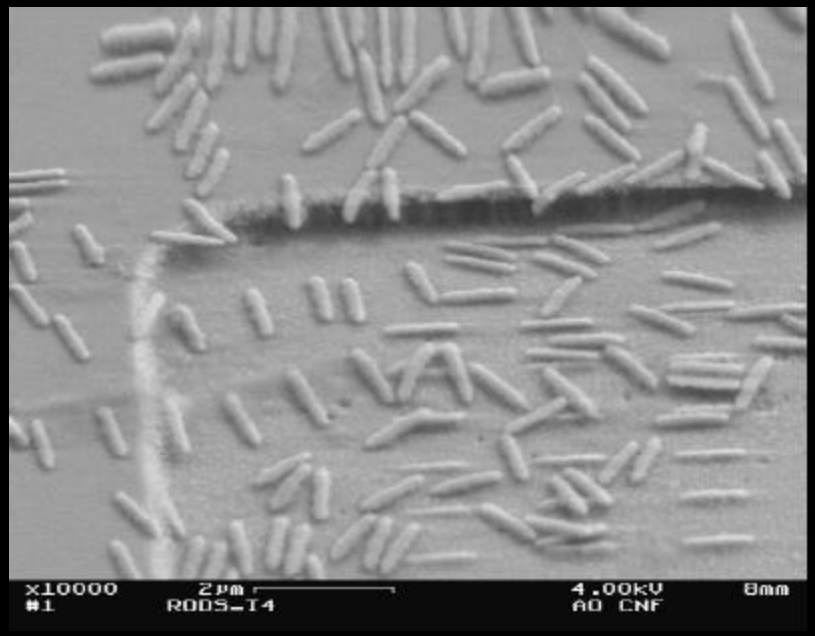


Nanofabricated Bars

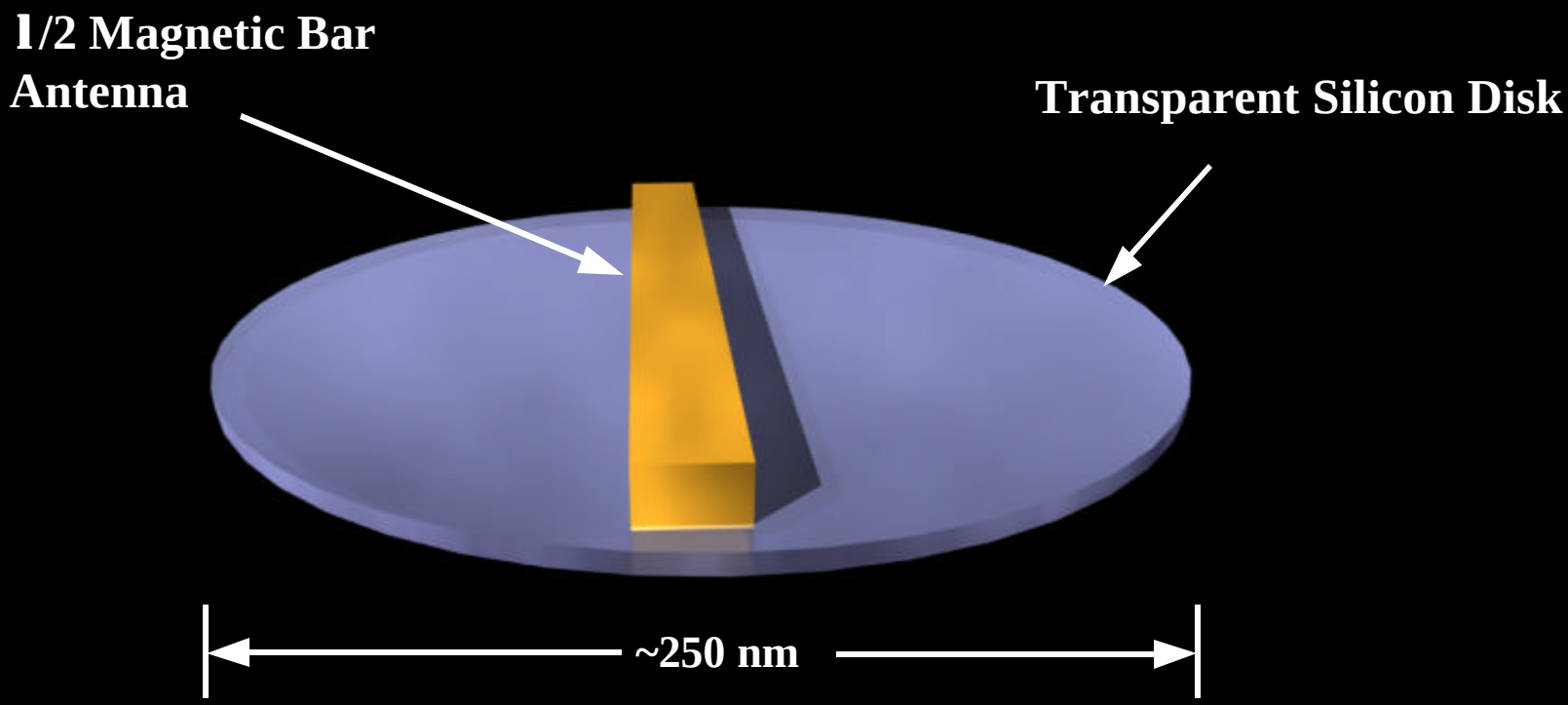


Release of Nanofabricated Rods

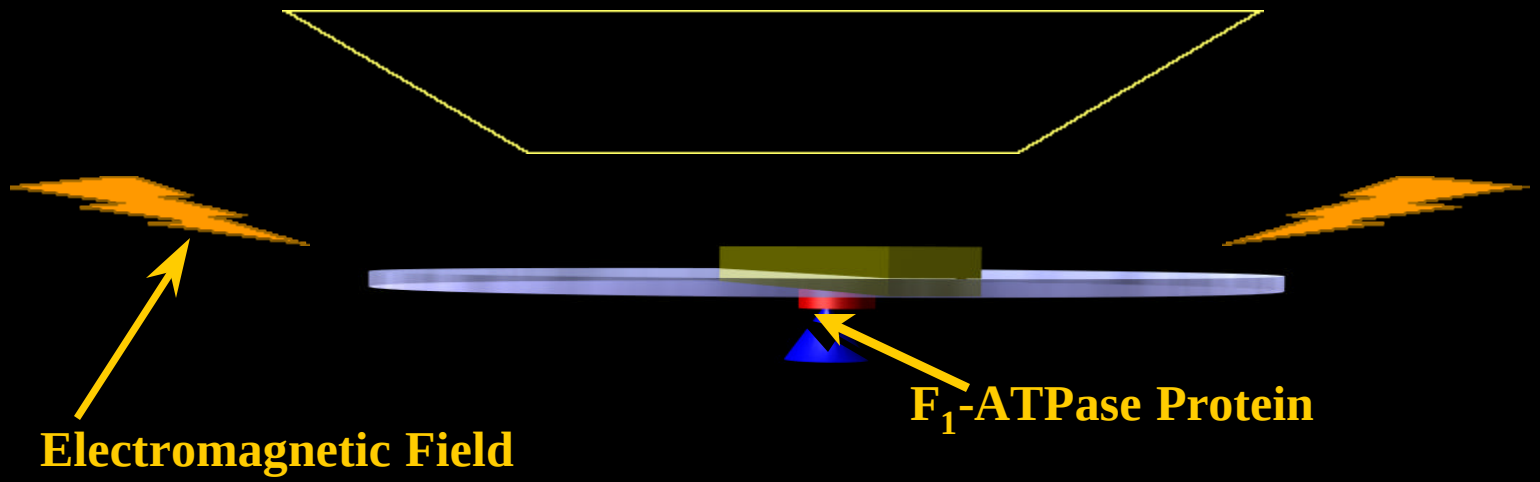




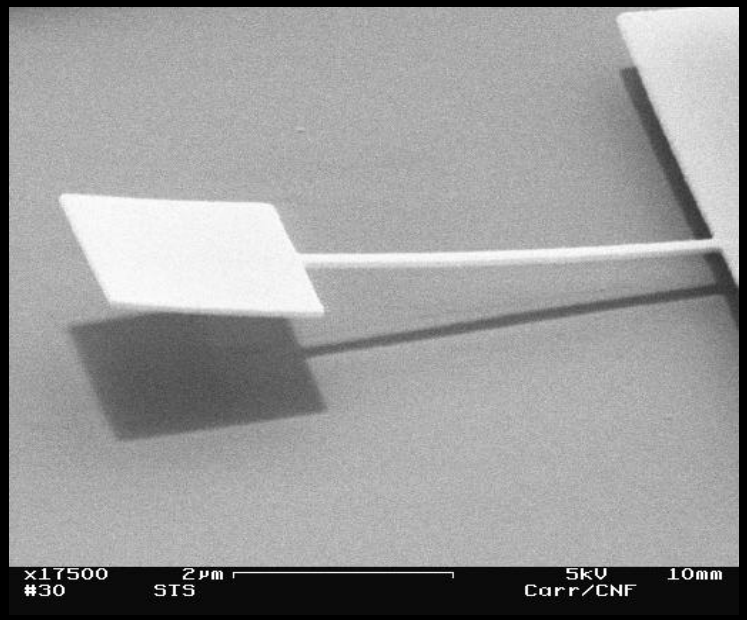
Reporter and Controller for the F_1-ATPase Motor Protein



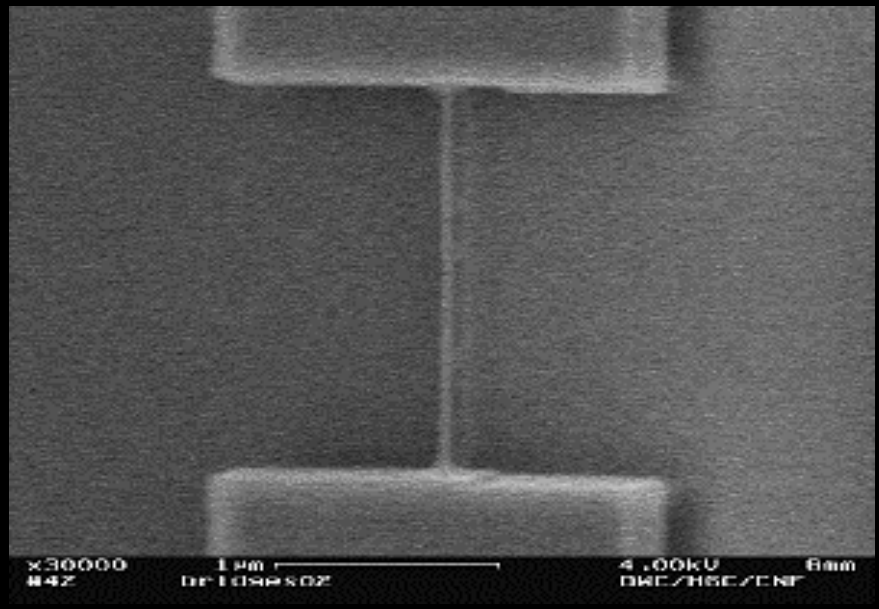
Control and Detection of Motor Protein Rotation



SEM Image of Nanostructures

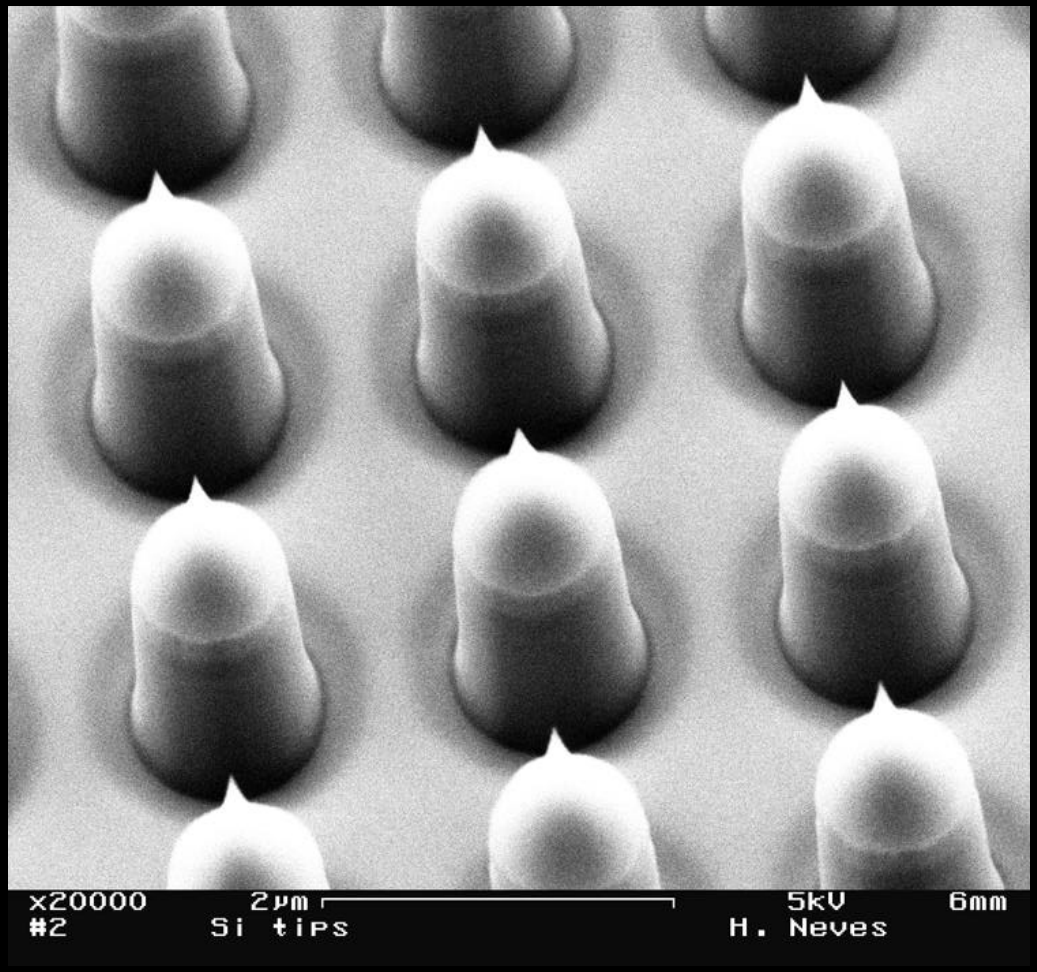


Deflecting cantilever with mirror

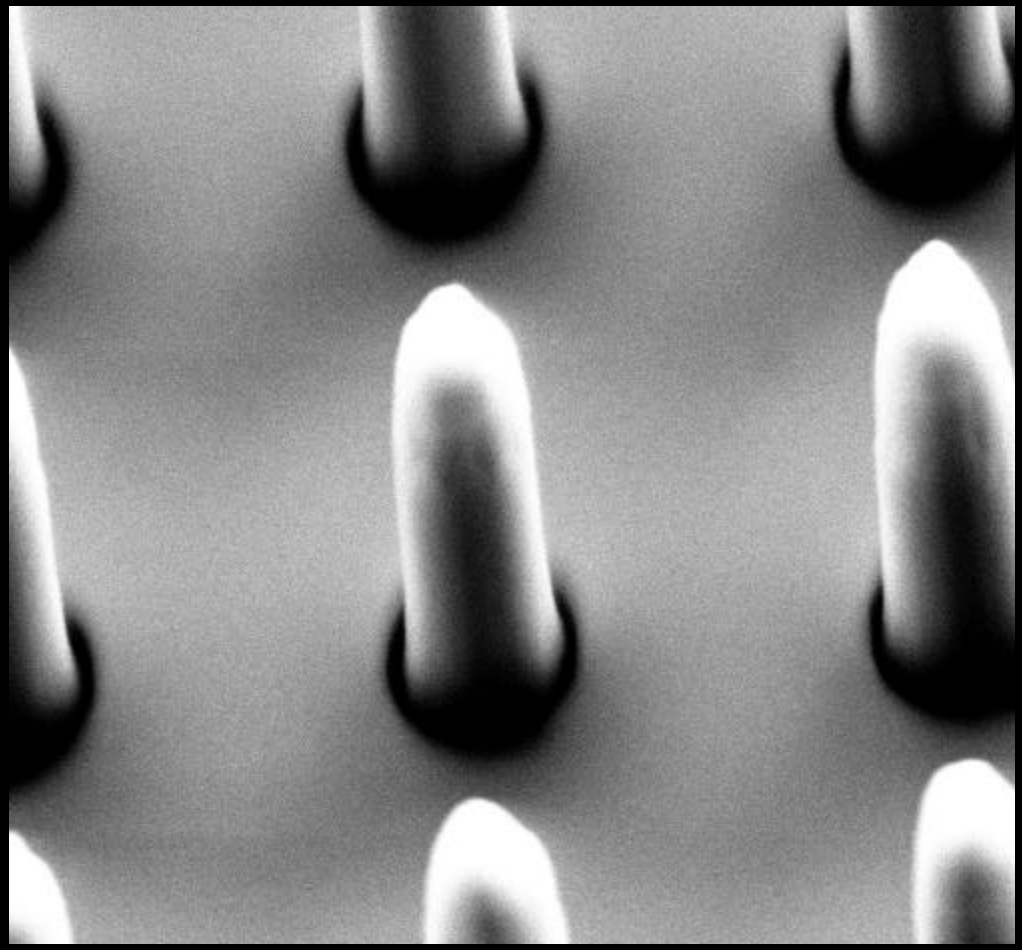


~30 nm wide suspended single crystal Si beam

Nano-imprinting mold



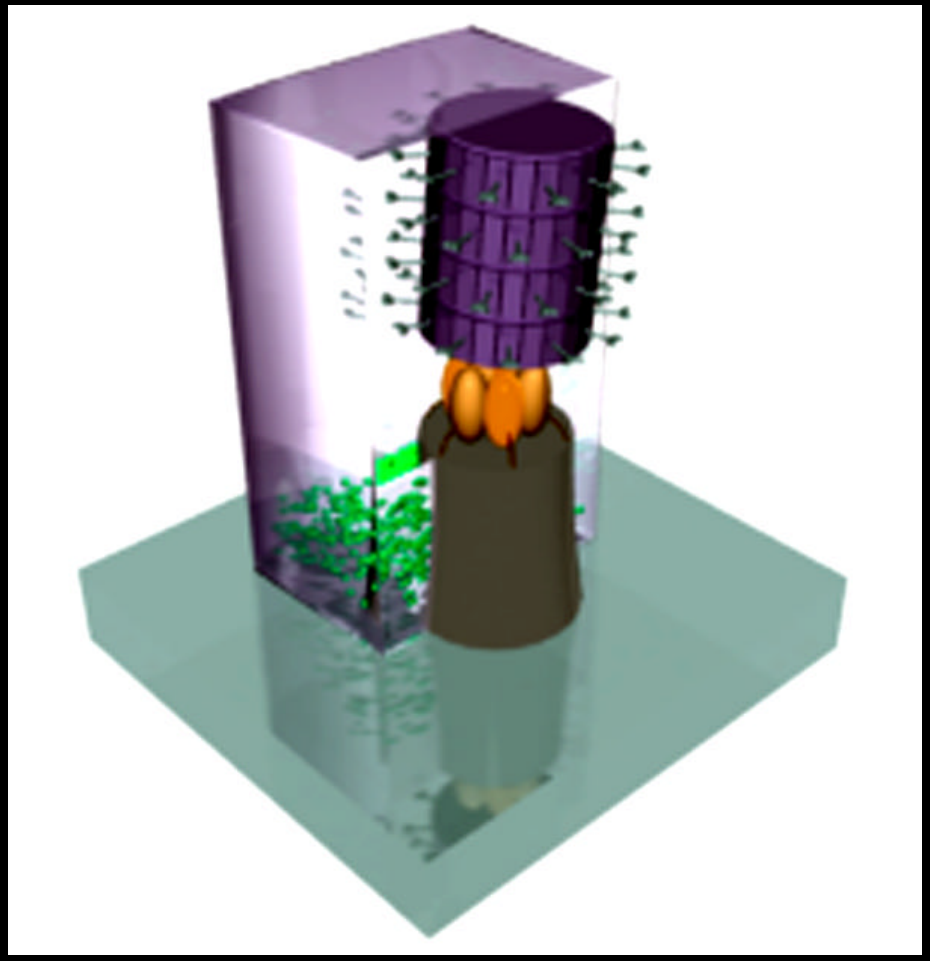
Nanofabricated Molecule Collectors



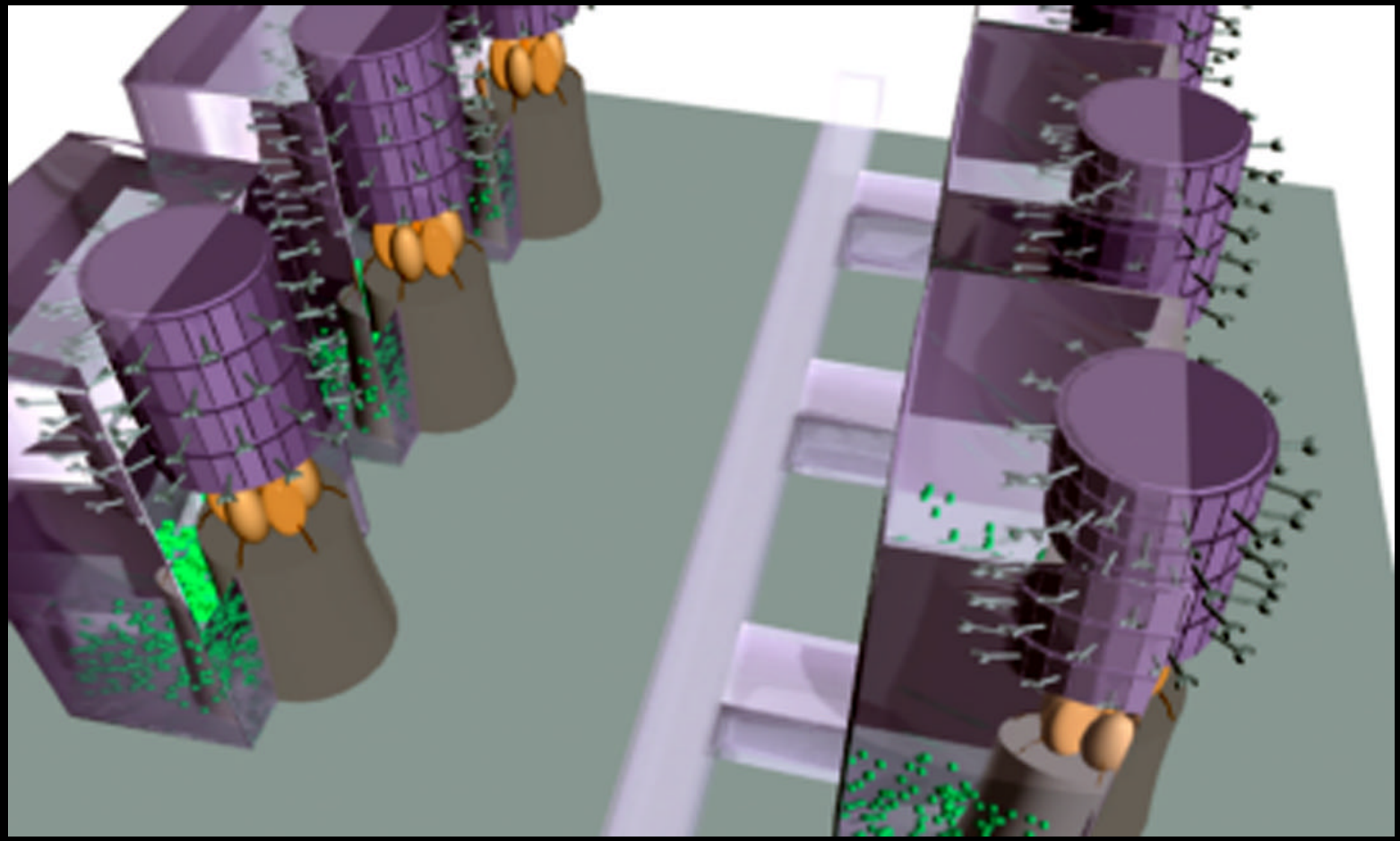
Future Applications and Research

- Biophysical evaluation → nano-propeller
- Biochemical switch → control motor function
- Fueling system → light driven ATP production
- Intracellular pharmacy → F_1-ATPase-powered drug delivery system
- Smart dust → F_1-ATPase-powered biosensing system

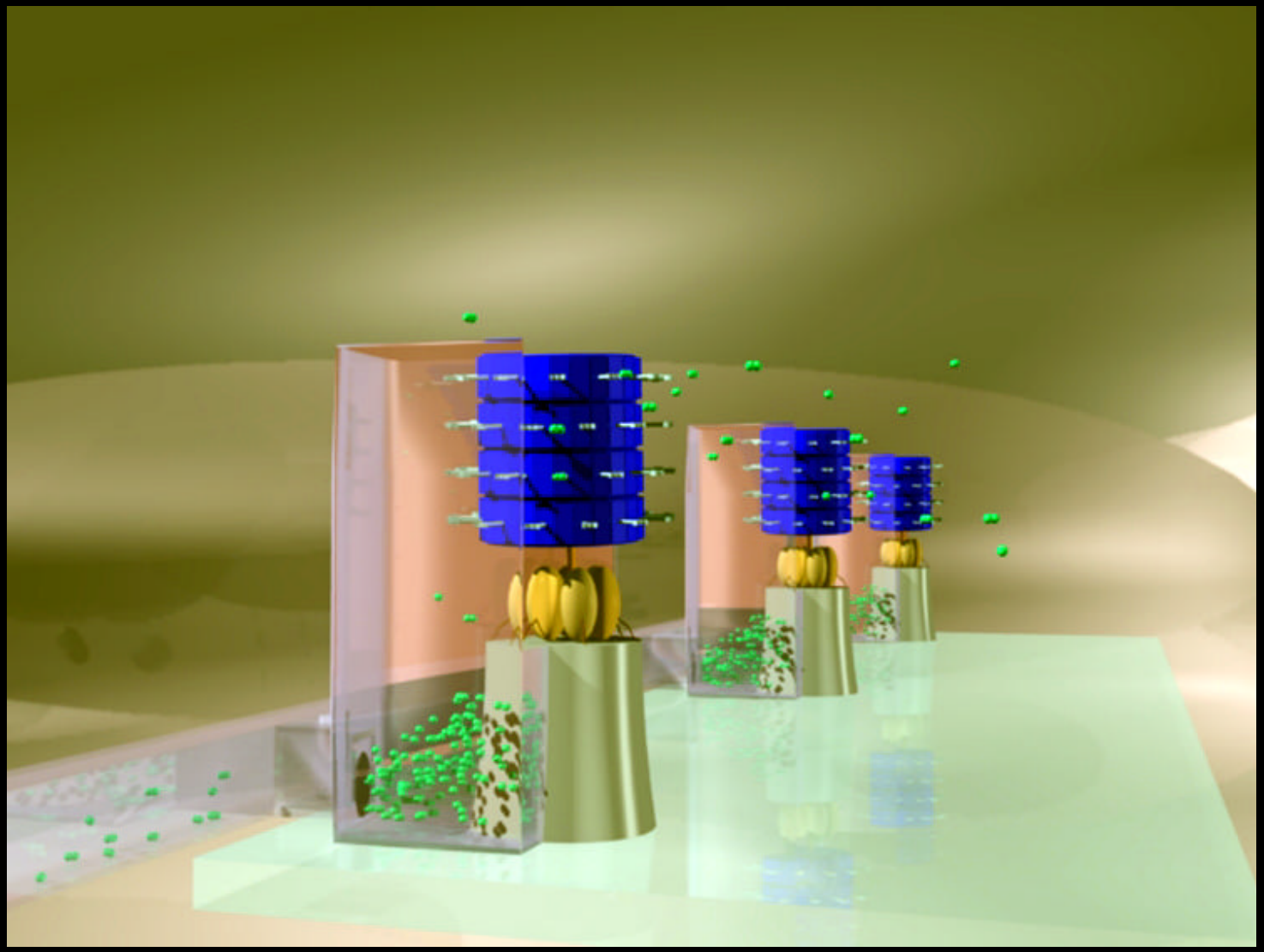
Single F_1-ATPase-powered Molecule Sorter



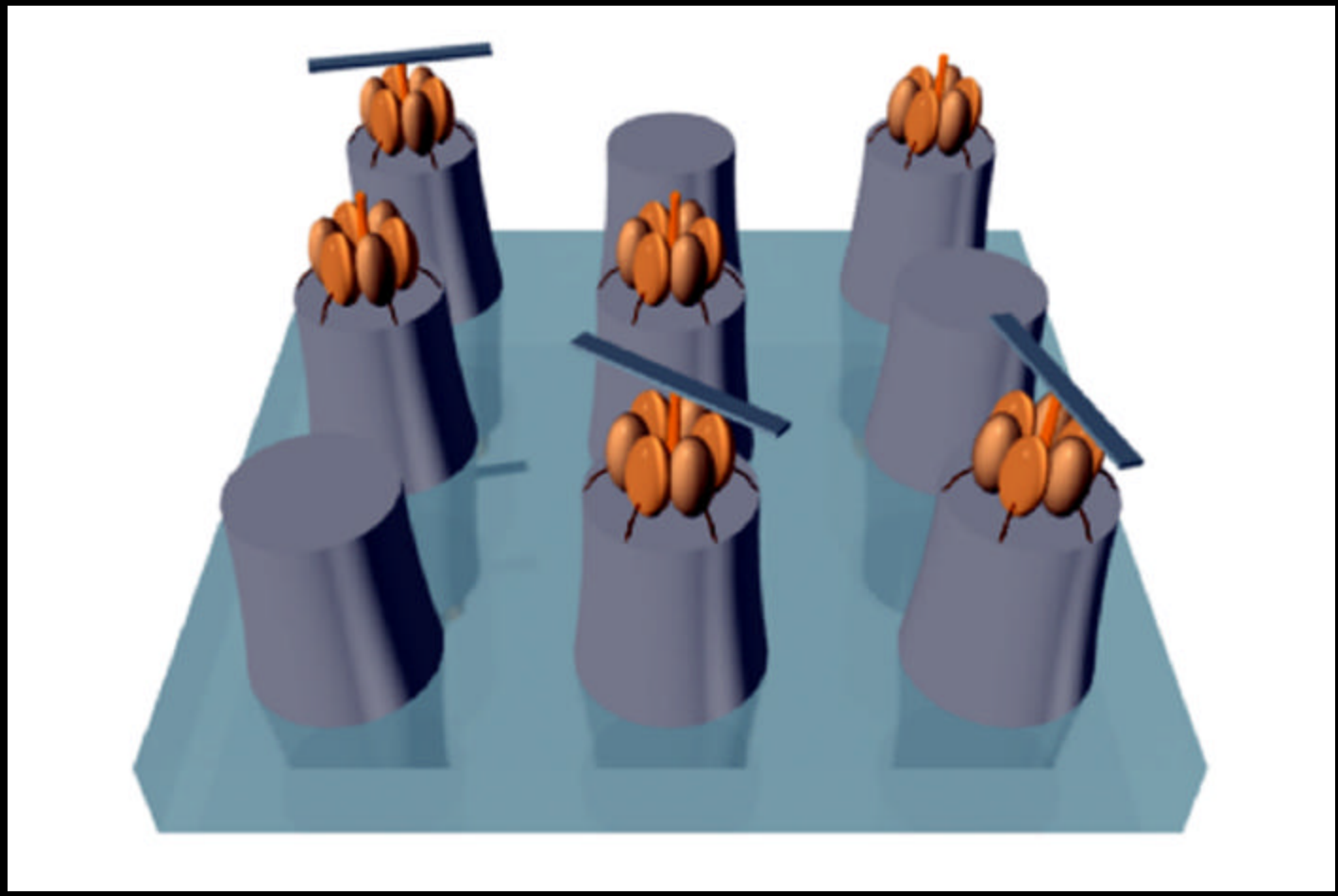
F_1-ATPase-powered Molecule Sorter



Intracellular Nanofabricated Molecule Sorter



F_1-ATPase-powered Nano-propellers



Interdisciplinary Diversity

Post Graduate, Graduate, and Undergraduate Students

- Biochemistry
- Applied Physics
- Cellular and Molecular Biology
- Electrical Engineering
- Chemical Engineering
- Materials Science
- Biomedical Engineering
- Agricultural and Biological Engineering

Collaborators

- Cornell University
  - Harold Craighead
  - George Bachand
  - Hercules Neves
  - CNF Staff
- Duke University Medical Center
  - Homme Hellinga
- Tokyo Institute of Technology
  - Massesuke Yoshida
  - Hiroyuki Noji
- Wayne State University
  - William Brusilow
- Graduate Students
  - Ricky Soong
  - Vivak Mohan
  - Anatoli Olkhovets
  - Taylen Sen
- Technicians
  - Marlene Bachand
  - Evan Brooks
  - Daniel Fulop
  - Nancy Walker

Acknowledgements

Office of Naval Research

Office of Basic Energy Sciences
Serving the Present, Shaping the Future

DARPA Defense Advanced Research Projects Agency

NSF
National Science Foundation

Life & Microgravity Sciences and Applications
LIFE SCIENCES

Return to Agenda

Next Presentation